MM 30 Symposium Nano Wires (SYNW)

Time: Thursday 11:00–13:15 Room: IFW D

MM 30.1 Thu 11:00 IFW D

Formation and Properties of Anodic TiO2 Nanotubes — •Patrik Schmuki, Julia Kunze, Hiroaki Tsuchiya, and Jan Macak — Uni Erlangen, Dept Mat. Sci, WW4

We present the electrochemical fabrication of self-organized high aspect ratio titanium oxide nanotubes achieved by an optimized and controlled anodization of Ti in fluoride containing solutions. In general, the morphology and the structure of porous layers are affected strongly by the electrochemical parameters used. Under optimized conditions self-organized highly ordered nanotubes with a length of several micrometers are formed consisting of arrays with single tube diameter of approx. 100 nm and a tube interval of 150 nm. Titanium oxides is a highly functional material that has numerous interesting properties, for example, in solar energy conversion, catalysis of decomposition of organic compounds (self-cleaning), wettability and biocompatibility. Therefore the tubes provide a novel functional and nanoscopic TiO2 form for numerous applications.

MM 30.2 Thu 11:15 IFW D

Formation of cobalt disilicide nanowires and nanochains in silicon by direct FIB writing — •Chavkat Akhmadaliev, Lothar Bischoff, Berndt Schmidt, and Arndt Mücklich — Forschungszentrum Rossendorf, Institute of Ion Beam Physics and Materials Research, P.O.Box 510119, 01314 Dresden

A Focused Ion Beam (FIB) equipped with a CoNd alloy liquid metal ion source was used for the formation of cobalt disilicide nanowires and nanochains by an ion beam synthesis process. Co ions at 60 keV were implanted into silicon (111) and (100) substrates at 400-450°C followed by a two-step annealing at 600°C and 1000°C. During the FIB patterning of the samples using a digital scanning system the dose, the pixel dwell time and the relaxation time between the irradiation cycles were varied. The FIB spot size was in the range of 40 nm. The formation of long, stable nanowires occurs along the favoured <110>-crystal direction. The misalignment of the FIB trace relative to this direction leads to a decay of the wire into shorter ones or to the formation of chains of single-crystalline nanoparticles. Nanowires of 20-80 nm diameter and lengths up to 50 microns were obtained. Imaging of nanostructures was done in-plane by SEM, AFM and TEM. Cross-sections through nanowires were prepared by conventional Ga FIB milling across the nanowire. Further efforts will be concentrated in a better control of the nanowires growth, in the characterization of the electrical properties and in the fabrication of nanodevices.

MM 30.3 Thu 11:30 IFW D

Simple water based hot plate syntheses for complex nanostructures like Nanotubes, Nanoneedles and Nanowires — •Mady Elbahri, Seid Jebril, Dadichi Paretkar, and Rainer Adelung — Christian Albrechts Universitaet kiel

1-D one dimensional nanostructure like nanowire , nanotube, nanorods, etc. have attracted significant attention due to their unique properties and hence find various applications1. Because such structures represent the gateway towards the world of nanoscale devices, numerous approaches have been developed. However, a huge interest for cost effective as well as rapid methods covering large areas with complex nanostructures still remains a challenge. We present a family of new water based non equilibrium syntheses of nanostructures on a hot plate. Within this approach, structures like the formation of carbon nanotubes, square millimeter large arrays of upstanding Na2CO3 nanowires with typical length of 20 micrometer but diameters below 100 nm or surface nanowires from ZnO nanorods was performed within. Reproducibility and properties will be critically discussed together with possible applications. [1] Y. Xia et al., Adv. Mater 15, 353, (2003)

MM 30.4 Thu 11:45 IFW D

Electrical characterization of nanowires with the LEEPS microscope — •Dirk Weber, Berthold Völkel, Andre Beyer, and Armin Gölzhäuser — Physik supramolekularer Systeme, Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld

We introduce the Low Energy Electron Point Source (LEEPS) microscope as a tool for the electrical characterization of nanowires. The LEEPS microscope is a transmission electron microscope with electron energies from 20eV to 200eV. These electrons are emitted by a field emission tip with a radius in the atomic range. Because the electrons have a high spatial coherence the resulting detector image is an interference pattern which includes the structural as well as electrical and magnetic information of the object. We will present an imaging study which compares LEEPS images of metallic, semiconducting and insulating nanowires. Certain features in the image are related to the conductivity of the wire, e.g. the brightness of the wire centre in comparison to the adjacent background. In addition we measured the conductance of single nanowires by using a metallic tip as a movable electrode and the sample support as its counterpart. Length dependant measurements allowed a distinction between the wire conductance and the contact resistance.

MM 30.5 Thu 12:00 IFW D

Electric Field Induced Low Temperature Oxidation of Tungsten Nanowires — •C. Nowak[1], G. Schmitz[2], and R. Kirchheim[1] — [1]Institut für Materialphysik, Universität Göttingen, D-37077 Göttingen — [2]Institut für Materialphysik, Universität Münster, D-48149 Münster

A study on room temperature oxidation of tungsten nanowires is presented, utilizing the high electric field arising at the tip of a nanowire if a moderate voltage is applied to influence the oxidation process.

Experiments were performed at room temperature under ambient atmosphere, TEM was applied to investigate the nanowires afterwards. Above a critical field strength, oxide layer formation occurs and is observed to virtually terminate at a field dependent state, determined by a critical field strength of $1.14(2) \times 10^9$ V/m at the oxide-gas interface. This allows the controlled formation of oxide layers up to several 10 nm thick in the high field region at the tip of the nanowires. Diffraction pattern analysis reveals that the oxide is vitreous or nanocrystalline with a grain size of several nanometers. Additionally considering the stoichiometry it is concluded that mainly WO_3 is formed. The observed electric field induced modification of the natural oxidation process is discussed within the scope of the Cabrera and Mott theory of low temperature oxidation, particularly focusing on the aspect of charge compensation at the oxide-gas interface.

MM 30.6 Thu 12:15 IFW D

Properties of simple metal nanowire devices fabricated by thin film fracture — •Rainer Adelung, Seid Jebril, Mady Elbahri, and Dadichi Paretkar — Christian Albrechts Universitaet Kiel

It turned out that a thin film fracture based method [1] is well suitable to integrate nanowires into microstructures [2]. Nanowires exhibit a pronounced sensitivity to a change of chemical surrounding [3,4]. This effect can be based on two different principles. If a nanowire contains nanogaps, molecules with an affinity to the nanowire material cover these gaps. Typically, the conductivity of such a host guest structure is increased as the filled gaps assist the hopping transport. Contrary, it was shown that very thin nanowires without gaps show a decrease of conductivity if exposed to molecules. This is explained with a reduction of conducting electrons by localization at the chemical bond between molecule and wire. The electrical properties of nanowire devices fabricated with the thin film fracture approach will be presented. Changes in conductivity after exposure to different chemical species will be discussed. Those will be related with the structure of the nanowires and the device geometry. [1] R. Adelung et al. Nat. mater., 3, 375, (2004). [2] Pat. Nr. PCT/DE 2005/001852, (2005). [3] F. Patolsky and C. M. Lieber, Materials today, April (2005). [4] T. Hassenkam et al. , Nano Lett. 4, 19 (2004).

MM 30.7 Thu 12:30 IFW D

Electrical Properties of Self-Assembled Iron Nano Chains — •Hanna Onneken[1], Tim Hülser[1,2], Hartmut Wiggers[2], and Axel Lorke[1] — [1]Institute of physics, University Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg, Germany — [2]Institute of combustion and gas dynamics, University Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg, Germany

We report on the electrical properties of self-assembled iron nanochains. Morphological, structural and magnetic investigations confirm the existence of chains up to 300μm lengths, consisting of iron nanoparticles with diameter of about 35nm. A surrounding iron oxide shell on the particles can be explained by a self-limited oxidation process in ambient atmosphere.

Single chains can be deposited on substrates for electrical characterization or consequently collected in a particle precipitator for subsequent processing. Impedance Spectroscopy (IS) on single chains reveals two contributions to the overall impedance. The first contribution, an ohmic resistance is originated by the iron core of each particle. The second results from the intergranular contact between adjacent particles with a capacitance between the conducting iron cores, surrounded by the shell. From the core contribution a specific resistance of 4.4×10^{-8} Ωm has been calculated; this value is of the same order as that of bulk iron. Agglomerated chains from the precipitator can be separated in ultrasonic baths using polar and nonpolar solvents and consequently contacted via electron beam lithography for IS analysis.

MM 30.8 Thu 12:45 IFW D

Electrical and Mechanical Characterization of Carbon/Metal Core/Shell Nanostructures and Pure Metallic Nanotubes — •Maik Eggers, Thorsten Staedler, and Xin Jiang — Institute of Materials Engineering, University of Siegen, Siegen, Germany

One-dimensional nanostructures have been objects of interest for quite a while now. Nevertheless, the direct assessment of their material properties is still afflicted with difficulties as their characteristic size causes various handling issues. Besides the electrical, magnetic, and optical behaviour, the mechanical properties of nanostructures are of special interest as these basically determine the possibility to use the structures in order to design mechanically stable devices. In this work carbon nitride nanobells (CNNBs) and carbon nitride fibers have been deposited by chemical vapour deposition (CVD) onto a silicon wafer. In a second step these structures have been electroplated with nickel, creating films of carbon/nickel core/shell structures. A series of samples with various nickel film thicknesses is available for electrical and mechanical testing. In a third step the carbon host structure is removed by hydrogen etching leaving behind pure nickel tubes. Both, individual carbon, carbon/nickel, and films/networks of these structures as well as single nickel tubes have been mechanically characterized by scanning nanoindentation and scanning probe microscopy. The complex results, which cover the mechanical response of the system on the nano- and micro-scale, will be correlated and discussed.

MM 30.9 Thu 13:00 IFW D

BEC magnetic field microscopy of polycrystalline Goldwires — •Simon Aigner[1], Leonardo Della Pietra[1], Ron Folman[2], and Jörg Schmiedmayer[1] — [1]Physikalisches Institut, Universität Heidelberg, Germany — [2]Ben Gurion University, Be'er Sheva, Israel

A Bose Einstein Condensate on an atom chip can be used to measure magnetic field deviations of the trapping potential to unprecedented accuracy [1]. From the measured magnetic field map one can reconstruct angular deviations from straight current flow down to better then 10^{-4}rad. We use this magnetic field microscope to characterize the electric current flow in precisely prepared nano fabricated test wires of thin poly-crystalline gold. The wires have different combinations of grain size (50nm and 140nm), thickness (0.25μm and 2μm) and width (5μm to 200μm), while the edges show a roughness between 10nm-40nm. From our measurements we hope to get a better understanding for the material parameters that lead to deviations in the current direction and the resulting fragmentation potentials in atom chip experiments. The test chip has been fabricated by the group of Ron Folman at Ben Gurion University. We want to acknowledge support by the DFG SCHM1599/2-2, EU:HPRN-CT-2002-00304 (FASTNet) and German-Israel Project DIP-F2.2.

[1] Wildermuth et al, Nature 435, 440 (26 May 2005)